

## Final Report

# The Bees (Hymenoptera: Apoidea) of Mount Wanda, John Muir National Historic Site: A Preliminary Assessment

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## **Introduction**

Bees are an essential component of biodiversity in their role as the primary pollinators of non-wind pollinated plants (Moldenke, 1979). The richness of the bee community can be directly affected by the conditions of the surrounding environment. Bees often specialize on specific plants or plant communities and are limited by the presence of appropriate plants as food resources in the form of pollen and nectar, the presence of nesting habitat and, in some groups, nest building materials (Westrich, 1996). Efforts to understand resulting pollinator patterns across North America are hampered by a dearth of local faunal studies (Williams et al., 2002). Comprehensive studies provide snapshots in time of a bee community and enable comparisons with historical inventories. Without these benchmarks, we have no method of gauging if the present assortment of bees and their associations with specific plants represents healthy pollination services.

Faunal studies of bees in California are limited but indicate a diverse fauna (Timberlake et al., 1950; Linsley, 1958; Moldenke and Neff, 1974). Recent studies in the Coast Range show remarkable diversity in a natural area, Pinnacles National Monument (Messinger & Griswold, 2003) and significant numbers even in urban areas (Frankie et al, 2003). Here we present results of a one-year study of native bees on the Mount Wanda tract of the John Muir National Historical Site (JMNHS).

The Mount Wanda area is part of the John Muir National Historic Site. Entrance to the Mount Wanda wild land of 325 acres is located about 1 mile south of the city center of Martinez in Contra Costa County, California. The area was first opened to the public in 1993. The two highest points in the area are 660' and 640', respectively. Slowly developing urbanization borders the northern and eastern sides of Mount Wanda. Locally managed ranch and parklands lie to the south and west.

There are several habitat types at Mt. Wanda. The largest, blue oak woodland, covers about 155 acres. Grassland covers 115 acres, mixed evergreen forest 55 acres. There are narrow bands of riparian habitat along some drainages. The most limited habitat is chaparral, which consists of only 2 acres scattered in two small isolated patches.

Mt. Wanda supports a rich flora of 283 plant species encompassing 66 families (Jepsen and Murdock 2003). Although a majority of these plants are native to California, there are also a substantial number of exotic species. The area was grazed until 1992. When cattle were removed as part of the management plan, exotic grasses flourished and commonly overtopped native plant species (Jepsen and Murdock 2003).

## **Materials and Methods**

Two habitat types were chosen for standardized bee monitoring plots: common blue oak woodland and open chaparral. In each habitat type one 200x50m plot was staked out on a prominent ridge bordered by steep hillsides. Bee monitoring at the study sites was conducted approximately once every three weeks from mid March 2002 to late September 2002. Usually three or four collectors, rarely two, did the monitoring from 0900 to 1500 local Pacific Time. Sampling conducted early in the season was Pacific Standard Time while later collections were Pacific Daylight Time.

Pan traps and hand netting were used to monitor bees at both sites. Thirty, 6 oz. Solo plastic bowls, 10 in each of three colors, florescent blue, florescent yellow, and white, were placed in sequence every 6-7m along the center line of the long axis in each of the plots. Each pan was filled with a soapy water solution (one tablespoon of regular "Blue Dawn" per gallon) to break the surface tension.

Once the pan traps were set out at 0900 for passive bee collections, aerial netting was conducted on all attractive floral hosts for one half hour within the 200x50m plots. Subsequently, aerial netting on flowers in areas surrounding each of the plots was conducted continuously until 1430. At that time aerial netting was resumed within each of the plots for an additional 30 minutes. Pan traps were emptied of their bees at 1500 using strainers, washed lightly with clean water and placed in Ziploc bags according to pan color for transport to the lab where they were rinsed again with clean water.

All bee host plants were identified to species in the field or were transported to the Jepson Herbarium at the University of California, Berkeley campus where they were identified by Barbara Ertter. Voucher collections of all host plants are housed in the laboratory of G. Frankie at UC Berkeley. All collected bees from pan traps and aerial nettings were pinned and labeled. Bees were sent to the USDA Bee

Biology and Systematics Laboratory (BBSL) in Logan, Utah for identification and analysis. Identified bees are deposited at the BBSL with synoptic collections returned to UC Berkeley.

## Results

Mount Wanda was sampled 12 times from March to September for a combined effort of 68 collector-days. Because of the paucity of flowers at the two collection sites in July, there were no bees hand netted from these areas. However, the presence of bees during this period was demonstrated by pan traps (6 species, 82 individuals).

Seventy species of bees in 26 genera and 6 families were collected in the Mount Wanda tract of the John Muir National Historical Site, a small subset of the more than 1200 species present in California (Moldenke, 1979). The majority of bee species collected were solitary, results comparable to the number of solitary bees found in the estimated 4000 North American species (Griswold et al, 1997). Cleptoparasites were poorly represented; only three species (4.4% of total species) were recorded from JMNHS. Eusocial Apidae, *Apis* and *Bombus*, represented only 8% of the species but were abundant (20% of the individuals). Cavity nesters were less diverse than ground-nesters among pollen-collecting bees (41% vs. 59%).

Bee diversity and abundance peaked in early spring (April/May, Fig. 1). Only six bee genera were collected after June versus the fifteen genera collected before June. The single peak in the phenology contrasts with regions experiencing summer monsoons where there is a distinct bimodal distribution of bees with peaks in bee diversity and abundance in both the spring and late summer (Griswold et al., 1997).

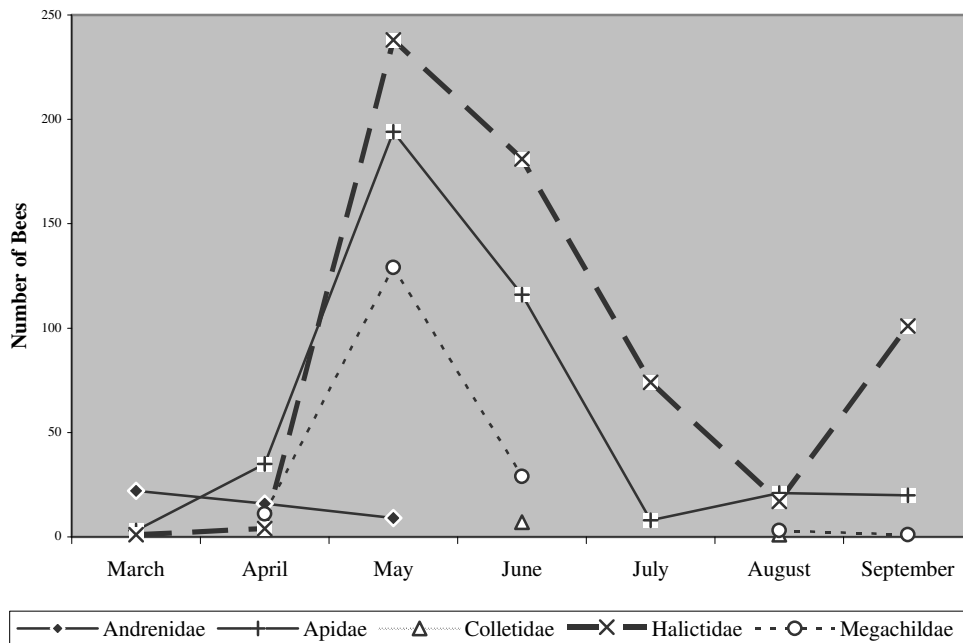


Fig.1. Abundance of bee families across the flowering season.

We recorded floral visitation records for 58 of the 70 bee species documented in JMNHS (Appendix A). Bees were collected on 19 families, 40 genera and 45 species of plants. Bees were not detected on the majority of the 283 species of flowering plants. Elements of the flora that attracted diverse bees included *Carduus*, *Centaurea*, *Holocarpha*, *Madia*, and *Silybum*; all were visited by ten or more species of bees. Bee species visited an average of 3 species of plants while every plant species was visited by 4.5 bee species on average. Polylectic, social genera like *Bombus*, *Apis* and *Halictus* visited a wide range of plants (13, 10 and 6 plant families respectively). A large proportion of bee species documented at JMNHS (46% of all species collected) were collected from plants in the family Asteraceae. The other 18 plant families attracted drastically fewer species of bees (1-20%). Exotic plants received more bee visits in

May and June than native plants (Figs. 2 & 3) even though in any given month there were more species of native plants visited by bees.

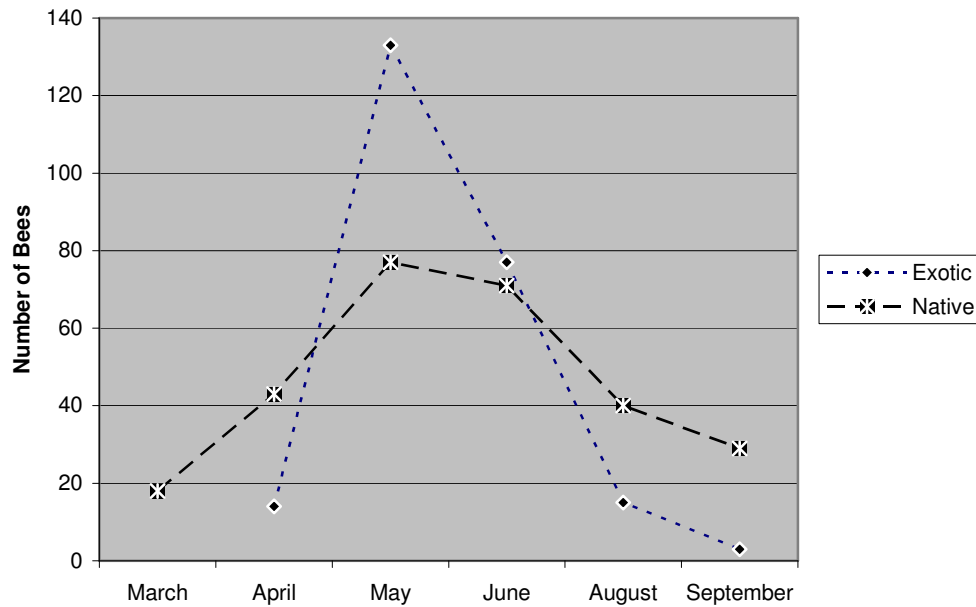


Fig. 2. Number of bees collected from native and exotic plants across the flowering season.

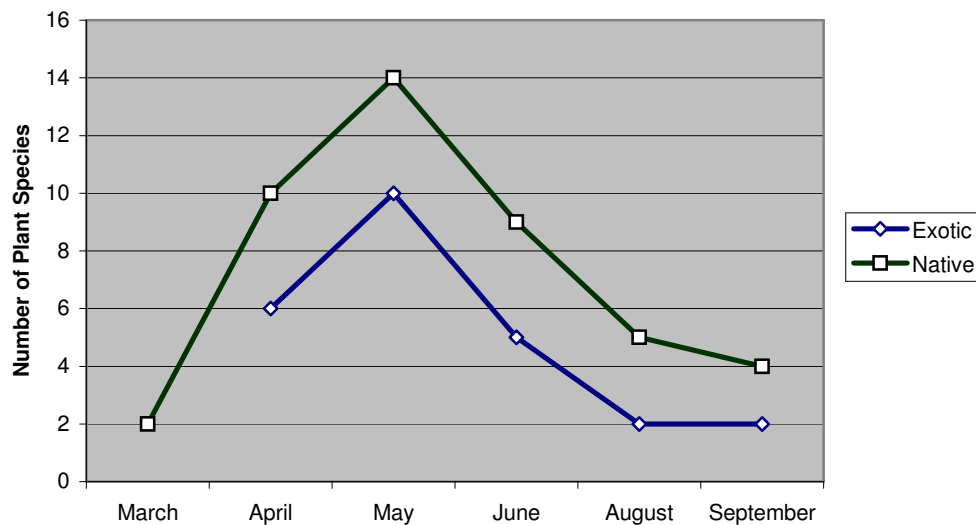


Fig. 3 Phenological changes in the diversity of exotic and native plants.

### Discussion:

The fauna documented in this study is not as diverse as expected. The present inventory is likely only part of the total species present and is an indication of limited collection. Woodland/chaparral bee communities at Stanford University; Mather, CA; and San Diego County, CA were found to have 136/176 species, 165/141 species and 135/171 species respectively in an 8 year pollination study using 0.5km<sup>2</sup> plots

(Moldenke, 1976). The known fauna of Mount Wanda is comparable to nearby urban areas in Berkeley and Albany, California (74 species, Frankie et al 2003).

One limitation of this study is the single year of sampling. In a four year study of Pinnacles National Monument, 31% of the bee species were present in only one year (Messinger & Griswold 2000). Use of species richness estimators (Colwell, 2004) suggest that the total number of species present is in the range of 100 to 180 species, diversity comparable to that recorded for similar habitats (Moldenke, 1976). Incomplete sampling of the floral bloom may also have been a factor in the lower than expected bee fauna. There were no collections before March, during which time floral bloom may have been present. A complete inventory of JMNHS would have to span several years and increased sampling effort at multiple collection sites throughout the entire blooming season.

Inventory methods that optimally detect bee faunal diversity are desirable. It has been suggested that by focusing on particular plants or plant families (such as the Asteraceae) as much as 80% of a known bee fauna can be detected (Williams et al., 2001). This study however suggests that fewer than 50% of the total bee inventory would be detected if the most visited family (Asteraceae) were sampled. Future efforts to expand the known inventory at JMNHS would profit more from more sampling sites and shorter intervals between collections than from focused studies on limited plant taxa. Frequent collections throughout the entire flowering season, sampling in all habitats, and sampling at all bee-attractive floral resources are key to developing robust pollinator inventories. While this study is far from a complete inventory of bees and their floral resources, it does provide a base line for future studies and management decisions.

### **Acknowledgements**

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**Appendix A. Floral associations of the bees of Mount Wanda.**

BEE			FLOWERING PLANT			
Family Name	Genus Name	Species	Family Name	Genus	Species Name	Exotic or Native
Andrenidae	Andrena	<i>angustitarsata</i>	Apiaceae	<i>Scandix</i>	<i>pecten-veneris</i>	Exotic
		<i>caerulea</i>	Ranunculaceae	<i>Ranunculus</i>	<i>californicus</i>	Native
		<i>cuneilabris</i>	Ranunculaceae	<i>Ranunculus</i>	<i>californicus</i>	Native
		<i>piperi</i>	Brassicaceae	<i>Sisymbrium</i>	<i>officinale</i>	Exotic
		<i>sladeni</i>	Geraniaceae	<i>Erodium</i>	<i>sp.</i>	?
		<i>suavis</i>	Ranunculaceae	<i>Ranunculus</i>	<i>californicus</i>	Native
	<i>Panurginus</i>	<i>nigrihirtus</i>	Ranunculaceae	<i>Ranunculus</i>	<i>californicus</i>	Native
Apidae	Anthophora	<i>californica</i>	Solanaceae	<i>Solanum</i>	<i>umbelliferum</i>	Native
	Apis	<i>mellifera</i>	Apiaceae	<i>Perideridia</i>	<i>kelloggii</i>	Native
				<i>Scandix</i>	<i>pecten-veneris</i>	Exotic
			Asclepiadaceae	<i>Asclepias</i>	<i>fascicularis</i>	Native
			Asteraceae	<i>Baccharis</i>	<i>pilularis</i>	Native
				<i>Carduus</i>	<i>pycnocephalus</i>	Exotic
				<i>Centaurea</i>	<i>solstitialis</i>	Exotic
				<i>Holocarpa</i>	<i>heermannii</i>	Native
				<i>Hypochaeris</i>	<i>glabra</i>	Exotic
				<i>Madia</i>	<i>elegans</i>	Native
				<i>Silybum</i>	<i>marianum</i>	Exotic
				<i>Sonchus</i>	<i>oleraceus</i>	Exotic
				<i>Wyethia</i>	<i>sp.</i>	Native
			Convolvulaceae	<i>Convolvulus</i>	<i>arvensis</i>	Exotic
			Euphorbiaceae	<i>Eremocarpus</i>	<i>setigerus</i>	Native
			Fabaceae	<i>Trifolium</i>	<i>hirtum</i>	Exotic
			Hippocastanaceae	<i>Aesculus</i>	<i>californica</i>	Native
			Onagraceae	<i>Clarkia</i>	<i>unguiculata</i>	Native
			Ranunculaceae	<i>Ranunculus</i>	<i>californicus</i>	Native
			Rosaceae	<i>Adenostoma</i>	<i>fasciculatum</i>	Native
	Bombus	<i>californicus</i>	Asclepiadaceae	<i>Asclepias</i>	<i>fascicularis</i>	Native
			Fabaceae	<i>Vicia</i>	<i>sativa</i>	Exotic
			Hippocastanaceae	<i>Aesculus</i>	<i>californica</i>	Native
			Lamiaceae	<i>Monardella</i>	<i>villosa</i>	Native
			Scrophulariaceae	<i>Collinsia</i>	<i>heterophylla</i>	Native
		<i>edwardsii</i>	Asteraceae	<i>Carduus</i>	<i>pycnocephalus</i>	Exotic
				<i>Silybum</i>	<i>marianum</i>	Exotic
			Brassicaceae	<i>Sisymbrium</i>	<i>officinale</i>	Exotic
			Fabaceae	<i>Trifolium</i>	<i>hirtum</i>	Exotic
			Scrophulariaceae	<i>Collinsia</i>	<i>heterophylla</i>	Native
		<i>griseocollis</i> <i>vosnesenskii</i>	Asteraceae	<i>Centaurea</i>	<i>solstitialis</i>	Exotic
			Apiaceae	<i>Torilis</i>	<i>nodosa</i>	Exotic
			Asteraceae	<i>Carduus</i>	<i>pycnocephalus</i>	Exotic
				<i>Centaurea</i>	<i>solstitialis</i>	Exotic
				<i>Hypochaeris</i>	<i>glabra</i>	Exotic
				<i>Madia</i>	<i>elegans</i>	Native

BEE			FLOWERING PLANT			
Family Name	Genus Name	Species	Family Name	Genus	Species Name	Exotic or Native
				<i>Silybum</i>	<i>marianum</i>	Exotic
				<i>Silybum</i>	<i>sp.</i>	Exotic
				<i>Wyethia</i>	<i>sp.</i>	Native
			Brassicaceae	<i>Sisymbrium</i>	<i>officinale</i>	Exotic
			Fabaceae	<i>Lotus</i>	<i>scoparius</i>	Exotic
				<i>Lupinus</i>	<i>bicolor</i>	Native
				<i>Lupinus</i>	<i>formosus</i>	Native
				<i>Trifolium</i>	<i>hirtum</i>	Exotic
				<i>Trifolium</i>	<i>willdenovii</i>	Native
			Hippocastanaceae	<i>Aesculus</i>	<i>californica</i>	Native
			Lamiaceae	<i>Monardella</i>	<i>villosa</i>	Native
				<i>Stachys</i>	<i>bullata</i>	Native
			Liliaceae	<i>Triteleia</i>	<i>laxa</i>	Native
			Onagraceae	<i>Clarkia</i>	<i>affinis</i>	Native
				<i>Clarkia</i>	<i>unguiculata</i>	Native
			Papaveraceae	<i>Eschscholzia</i>	<i>californica</i>	Native
			Rosaceae	<i>Adenostoma</i>	<i>fasciculatum</i>	Native
			Saxifragaceae	<i>Lithophragma</i>	<i>affine</i>	Native
			Scrophulariaceae	<i>Castilleja</i>	<i>exserta</i>	Native
				<i>Collinsia</i>	<i>heterophylla</i>	Native
	<i>Ceratina</i>	<i>acantha</i>	Asteraceae	<i>Centaurea</i>	<i>solstitialis</i>	Exotic
				<i>Convolvulus</i>	<i>arvensis</i>	Exotic
	<i>Diadasia</i>	<i>bituberculata</i>	Asteraceae	<i>Holocarpa</i>	<i>heermannii</i>	Native
	<i>Triepeolus</i>	<i>sp. 1</i>	Euphorbiaceae	<i>Eremocarpus</i>	<i>setigerus</i>	Native
	<i>Eucera</i>	<i>actuosa</i>	Fabaceae	<i>Medicago</i>	<i>polymorpha</i>	Exotic
			Fabaceae	<i>Trifolium</i>	<i>hirtum</i>	Exotic
		<i>cordleyi</i>	Asteraceae	<i>Carduus</i>	<i>pycnocephalus</i>	Exotic
			Boraginaceae	<i>Amsinckia</i>	<i>menziesii</i>	Native
			Fabaceae	<i>Vicia</i>	<i>sativa</i>	Exotic
			Liliaceae	<i>Triteleia</i>	<i>laxa</i>	Native
			Saxifragaceae	<i>Lithophragma</i>	<i>affine</i>	Native
		<i>frater</i>	Fabaceae	<i>Trifolium</i>	<i>hirtum</i>	Exotic
			Fabaceae	<i>Vicia</i>	<i>sativa</i>	Exotic
		<i>virgata</i>	Liliaceae	<i>Triteleia</i>	<i>laxa</i>	Native
			Scrophulariaceae	<i>Collinsia</i>	<i>heterophylla</i>	Native
	<i>Habropoda</i>	<i>tristissima</i>	Scrophulariaceae	<i>Castilleja</i>	<i>exserta</i>	Native
				<i>Collinsia</i>	<i>heterophylla</i>	Native
	<i>Melissodes</i>	<i>lupina</i>	Asteraceae	<i>Carduus</i>	<i>pycnocephalus</i>	Exotic
				<i>Centaurea</i>	<i>solstitialis</i>	Exotic
				<i>Holocarpa</i>	<i>heermannii</i>	Native
			Euphorbiaceae	<i>Eremocarpus</i>	<i>setigerus</i>	Native
		<i>stearnsi</i>	Scrophulariaceae	<i>Mimulus</i>	<i>aurantiacus</i>	Native
			Asteraceae	<i>Centaurea</i>	<i>solstitialis</i>	Exotic
				<i>Holocarpa</i>	<i>heermannii</i>	Native
	<i>Svastra</i>	<i>obliqua</i>	Asteraceae	<i>Centaurea</i>	<i>solstitialis</i>	Exotic



BEE			FLOWERING PLANT			
Family Name	Genus Name	Species	Family Name	Genus	Species Name	Exotic or Native
	<i>Tetraloniella</i>	<i>pomona</i>	<b>Asteraceae</b>	<i>Holocarpha</i>	<i>heermannii</i>	Native
				<i>Madia</i>	<i>elegans</i>	Native
	<i>Xylocopa</i>	<i>tabaniformis</i>	<b>Asteraceae</b>	<i>Madia</i>	<i>elegans</i>	Native
			<b>Fabaceae</b>	<i>Lotus</i>	<i>scoparius</i>	Exotic
			<b>Fabaceae</b>	<i>Vicia</i>	<i>sativa</i>	Exotic
			<b>Scrophulariaceae</b>	<i>Mimulus</i>	<i>aurantiacus</i>	Native
<b>Colletidae</b>	<i>Colletes</i>	<i>fulgidus</i>	<b>Asteraceae</b>	<i>Holocarpha</i>	<i>heermannii</i>	Native
	<i>Hylaeus</i>	<i>coloradensis</i>	<b>Apiaceae</b>	<i>Perideridia</i>	<i>kelloggii</i>	Native
		<i>granulatus?</i>	<b>Apiaceae</b>	<i>Perideridia</i>	<i>kelloggii</i>	Native
<b>Halictidae</b>	<i>Agapostemon</i>	<i>angelicus/texanus</i>	<b>Asteraceae</b>	<i>Wyethia</i>	<i>sp.</i>	Native
	<i>Halictus</i>	<i>farinosus</i>	<b>Geraniaceae</b>	<i>Erodium</i>	<i>sp.</i>	
			<b>Asteraceae</b>	<i>Madia</i>	<i>elegans</i>	Native
				<i>Silybum</i>	<i>marianum</i>	Exotic
			<b>Liliaceae</b>	<i>Triteleia</i>	<i>laxa</i>	Native
			<b>Scrophulariaceae</b>	<i>Mimulus</i>	<i>aurantiacus</i>	Native
		<i>tripartitus</i>	<b>Apiaceae</b>	<i>Perideridia</i>	<i>kelloggii</i>	Native
			<b>Asteraceae</b>	<i>Centaurea</i>	<i>solstitialis</i>	Exotic
				<i>Holocarpha</i>	<i>heermannii</i>	Native
				<i>Madia</i>	<i>elegans</i>	Native
			<b>Convolvulaceae</b>	<i>Convolvulus</i>	<i>arvensis</i>	Exotic
			<b>Euphorbiaceae</b>	<i>Eremocarpus</i>	<i>setigerus</i>	Native
	<i>Lasioglossum</i>	<i>incompletus</i>	<b>Apiaceae</b>	<i>Perideridia</i>	<i>kelloggii</i>	Native
			<b>Asclepiadaceae</b>	<i>Asclepias</i>	<i>fascicularis</i>	Native
			<b>Asteraceae</b>	<i>Centaurea</i>	<i>solstitialis</i>	Exotic
				<i>Holocarpha</i>	<i>heermannii</i>	Native
			<b>Convolvulaceae</b>	<i>Convolvulus</i>	<i>arvensis</i>	Exotic
			<b>Euphorbiaceae</b>	<i>Eremocarpus</i>	<i>setigerus</i>	Native
		<i>titusi</i>	<b>Asteraceae</b>	<i>Achillea</i>	<i>sp.</i>	Native
				<i>Carduus</i>	<i>pycnocephalus</i>	Exotic
				<i>Eriophyllum</i>	<i>confertiflorum</i>	Native
				<i>Holocarpha</i>	<i>heermannii</i>	Native
				<i>Hypochaeris</i>	<i>glabra</i>	Exotic
				<i>Madia</i>	<i>elegans</i>	Native
				<i>Sonchus</i>	<i>oleraceus</i>	Exotic
				<i>Wyethia</i>	<i>sp.</i>	Native
			<b>Convolvulaceae</b>	<i>Convolvulus</i>	<i>arvensis</i>	Exotic
<b>Megachilidae</b>	<i>Ashmeadiella</i>	<i>californica</i>	<b>Asteraceae</b>	<i>Madia</i>	<i>elegans</i>	Native
				<i>Senecio</i>	<i>californicus</i>	Native
	<i>Hoplitis</i>	<i>albifrons</i>	<b>Asteraceae</b>	<i>Silybum</i>	<i>marianum</i>	Exotic
		<i>howardi</i>	<b>Onagraceae</b>	<i>Clarkia</i>	<i>unguiculata</i>	Native
	<i>Megachile</i>	<i>apicalis</i>	<b>Fabaceae</b>	<i>Lotus</i>	<i>scoparius</i>	Exotic
				<i>Lotus</i>	<i>scoparius</i>	Exotic
		<i>apicalis</i>	<b>Asteraceae</b>	<i>Carduus</i>	<i>pycnocephalus</i>	Exotic
				<i>Centaurea</i>	<i>solstitialis</i>	Exotic
		<i>fidelis</i>	<b>Lamiaceae</b>	<i>Monardella</i>	<i>villosa</i>	Native
		<i>montivaga</i>	<b>Asteraceae</b>	<i>Holocarpha</i>	<i>heermannii</i>	Native
			<b>Asteraceae</b>	<i>Carduus</i>	<i>pycnocephalus</i>	Exotic

BEE			FLOWERING PLANT			
Family Name	Genus Name	Species	Family Name	Genus	Species Name	Exotic or Native
				<i>Silybum</i>	<i>marianum</i>	Exotic
		<i>pugnata</i>	<b>Asteraceae</b>	<i>Centaurea</i>	<i>solstitialis</i>	Exotic
				<i>Madia</i>	<i>elegans</i>	Native
	<i>Osmia</i>	<i>atrocyanea</i>	<b>Asteraceae</b>	<i>Carduus</i>	<i>pycnocephalus</i>	Exotic
		<i>californica</i>	<b>Asteraceae</b>	<i>Carduus</i>	<i>pycnocephalus</i>	Exotic
				<i>Silybum</i>	<i>marianum</i>	Exotic
				<i>Carduus</i>	<i>pycnocephalus</i>	Exotic
		<i>coloradensis</i>	<b>Asteraceae</b>	<i>Hypochaeris</i>	<i>glabra</i>	Exotic
				<i>Silybum</i>	<i>marianum</i>	Exotic
				<i>Carduus</i>	<i>pycnocephalus</i>	Exotic
			<b>Fabaceae</b>	<i>Medicago</i>	<i>polymorpha</i>	Exotic
			<b>Onagraceae</b>	<i>Clarkia</i>	<i>affinis</i>	Native
		<i>cyanella</i>	<b>Scrophulariaceae</b>	<i>Collinsia</i>	<i>heterophylla</i>	Native
				<i>Mimulus</i>	<i>aurantiacus</i>	Native
		<i>gabrielis</i>	<b>Fabaceae</b>	<i>Trifolium</i>	<i>willdenovii</i>	Native
			<b>Scrophulariaceae</b>	<i>Castilleja</i>	<i>exserta</i>	Native
				<i>Mimulus</i>	<i>aurantiacus</i>	Native
		<i>granulosa</i>	<b>Asteraceae</b>	<i>Hypochaeris</i>	<i>glabra</i>	Exotic
			<b>Fabaceae</b>	<i>Lotus</i>	<i>scoparius</i>	Exotic
			<b>Liliaceae</b>	<i>Triteleia</i>	<i>laxa</i>	Native
			<b>Scrophulariaceae</b>	<i>Castilleja</i>	<i>rubicundula</i>	Native
				<i>Mimulus</i>	<i>aurantiacus</i>	Native
		<i>laeta</i>	<b>Fabaceae</b>	<i>Lotus</i>	<i>scoparius</i>	Exotic
		<i>lignaria</i>	<b>Fabaceae</b>	<i>Trifolium</i>	<i>hirtum</i>	Exotic
		<i>montana</i>	<b>Asteraceae</b>	<i>Hypochaeris</i>	<i>glabra</i>	Exotic
				<i>Silybum</i>	<i>marianum</i>	Exotic
				<i>Wyethia</i>	<i>sp.</i>	Native
		<i>nemoris</i>	<b>Asteraceae</b>	<i>Carduus</i>	<i>pycnocephalus</i>	Exotic
			<b>Fabaceae</b>	<i>Trifolium</i>	<i>hirtum</i>	Exotic
		<i>texana</i>	<b>Asteraceae</b>	<i>Silybum</i>	<i>marianum</i>	Exotic
		<i>tristella</i>	<b>Asteraceae</b>	<i>Carduus</i>	<i>pycnocephalus</i>	Exotic
			<b>Fabaceae</b>	<i>Lotus</i>	<i>scoparius</i>	Exotic
			<b>Scrophulariaceae</b>	<i>Mimulus</i>	<i>aurantiacus</i>	Native
	<i>Protosmia</i>	<i>rubifloris</i>	<b>Boraginaceae</b>	<i>Amsinckia</i>	<i>menziesii</i>	Native

**Appendix B. Hierarchical list of Mount Wanda bees with phenology and nesting habits.**  
(Numbers indicate counts of specimens/month.)

Family	Subfamily orTribe	Genus	Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Ground Nesting	Cavity Nesting	Parasitic	
Andrenidae	Andreninae	<i>Andrena</i>	<i>angustitarsata</i>		1						x			
			<i>caerulea</i>		1	3					x			
			<i>cuneilabris</i>	5	1						x			
			<i>piperi</i>			1					x			
			<i>sladeni</i>		3	1					x			
			<i>sola</i>			1					x			
			<i>suavis</i>	12	6	2					x			
	Panurgini	<i>Panurginus</i>	<i>nigrihirtus</i>	5	4						x			
			<i>californica</i>		1						x			
	Anthophorini	<i>Anthophora</i>	<i>edwardsii</i>	1							x			
			<i>urbana</i>							1	x			
	Apidae	Apini	<i>Habropoda</i>	<i>tristissima</i>			4					x		
				<i>Apis</i>	<i>mellifera</i>	1	3	21	18		2	4		x
					<i>californicus</i>		2		6				x	
Bombini		<i>Bombus</i>	<i>edwardsii</i>		1	7					x			
			<i>griseocollis</i>				1				x			
			<i>vosnesenskii</i>		15	95	70	2			x			
			<i>acantha</i>						1	2		x		
Ceratinini		<i>Ceratina</i>	<i>nanula</i>			5		2	1	1		x		
			<i>sequoiae</i>			7			1			x		
			<i>bituberculata</i>			1	1				x			
Epeolini		<i>Doeringiella</i>	<i>sp. 1</i>							1			x	
Eucerini		<i>Eucera</i>	<i>actuosa</i>		1	13						x		
			<i>cordleyi</i>		8	5						x		
			<i>frater</i>		1	3						x		
	<i>virgata</i>				29	3					x			
	<i>Melissodes</i>	<i>lupina</i>		1	1	11	4	1	5		x			
		<i>stearnsi</i>						4	5		x			
		<i>Svastra</i>	<i>obliqua</i>				2				x			
		<i>Tetraloniella</i>	<i>pomona</i>				3		10	2	x			
	Nomadini	<i>Nomada</i>	<i>sp. A</i>	1									x	
	Xylocopini	<i>Xylocopa</i>	<i>tabaniformis</i>		2	3	1					x		
	Colletidae	Colletinae	<i>Colletes</i>	<i>fulgidus</i>							1	x		
				<i>coloradensis</i>				5					x	
		Hylaeinae	<i>Hylaeus</i>	<i>granulatus?</i>				2	1				x	
				<i>angelicus/texanus</i>	4	5	4	3	5	1		x		
Halictidae	Halictini	<i>Agapostemon</i>	<i>farinosus</i>	1		14	5				x			
			<i>tripartitus</i>			77	60	39	37	7	x			
		<i>incompletus</i>			71	77	29	48	5	x				
		<i>Halictus</i>	<i>mellipes</i>			3					x			
			<i>ruidosensis</i>			12	1		1		x			
			<i>Lasioglossum</i>	<i>sp. 1</i>			1				x			
				<i>sp. 16</i>			1				x			
		<i>sp. B</i>				4	2			x				
		<i>sp. E</i>				1	8	2	5	x				

## Appendix B (cont.)

Family	Subfamily orTribe	Genus	Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Ground Nesting	Cavity Nesting	Parasitic	
Halictidae	Halictini	<i>Lasioglossum</i>	<i>titusi</i>	1		47	22		4	3	x			
	Anthidiini	<i>Stelis</i>	<i>montana</i>			3							x	
			<i>apicalis</i>				9		1			x		
	Megachilini	<i>Megachile</i>	<i>fidelis</i>				2			3			x	
			<i>montivaga</i>			1	1						x	
		<i>Ashmeadiella</i>	<i>bucconis</i>				1						x	
			<i>californica</i>			1	1					x		
		<i>Hoplitis</i>	<i>albifrons</i>			6						x		
			<i>howardi</i>			5						x		
			<i>atrocyanea</i>				1					x		
			<i>californica</i>			13	2					x		
			<i>coloradensis</i>		6	19	3					x		
	Megachildae			<i>cyanella</i>		1	1							
		Osmiini		<i>gabrielis</i>		2	30							
				<i>glauca</i>			5							x
<i>Osmia</i>			<i>granulosa</i>			19	6							
			<i>laeta</i>			1								
			<i>lignaria</i>			1						x		
			<i>montana</i>		2	5						x		
			<i>nemoris</i>			7	2				x			
			<i>pusilla</i>			1								
			<i>texana</i>			2	1					x		
			<i>tristella</i>		1	8						x		
		<i>Protosmia</i>	<i>rubifloris</i>		1	2						x		